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SPECIES ADAPTABILITY IN THE PICEANCE BASIN
FOR REVEGETATING SOILS DISTURBED
BY OIL SHALE DEVELOPMENT

Preliminary Report
June 30, 1976
Area Oil Shale Office
USGS

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SPECIES EVALUATION OF PICEANCE BASIN

The species observed in mid-May of 1976 can be grouped into three categories. The first of these were species well adapted to conditions present on the site. The second grouping was assigned to those species showing some promise for revegetation, but not enough to be used as potential species by themselves. These species would be included to fill gaps and add diversity with the well adapted vegetation. The last classification was designated for species showing little promise and poor site adaptability.

To classify as a well adapted species, a seeded species must show superior seedling and yearly emergence and vigor. This is rated on a scale of 0-4, with "0" denoting no growth, "1" indicating poor characteristics, "2" as fair, "3" as good and "4" as exhibiting excellent growth habits. The species were rated with relation to 1976 observations and the previous years' compiled data (1972-1975). The well adapted species have averages in the neighborhood of 2-2.5 to 4. The seeded species are evaluated by site in relation to the best seeded stand present therein. That is to say, species on the sagebrush plot are not rated in relation to those on the mountain browse, but in relation to their own site location.

In the grouping for species showing some promise, species must have averages ranging roughly from .8 to 1.9, or in the case of shrubs, sufficient plant growth and size to warrant its continuation in revegetation work.

Those species showing less than .8 are grouped in the final category. These species offer only marginal, at best, site applications.

Each of the four sites sampled will be discussed and the species will be placed in the various categories. The four sites are: mid-elevation sagebrush, low pinyon-juniper, high pinyon-juniper and mountain browse.

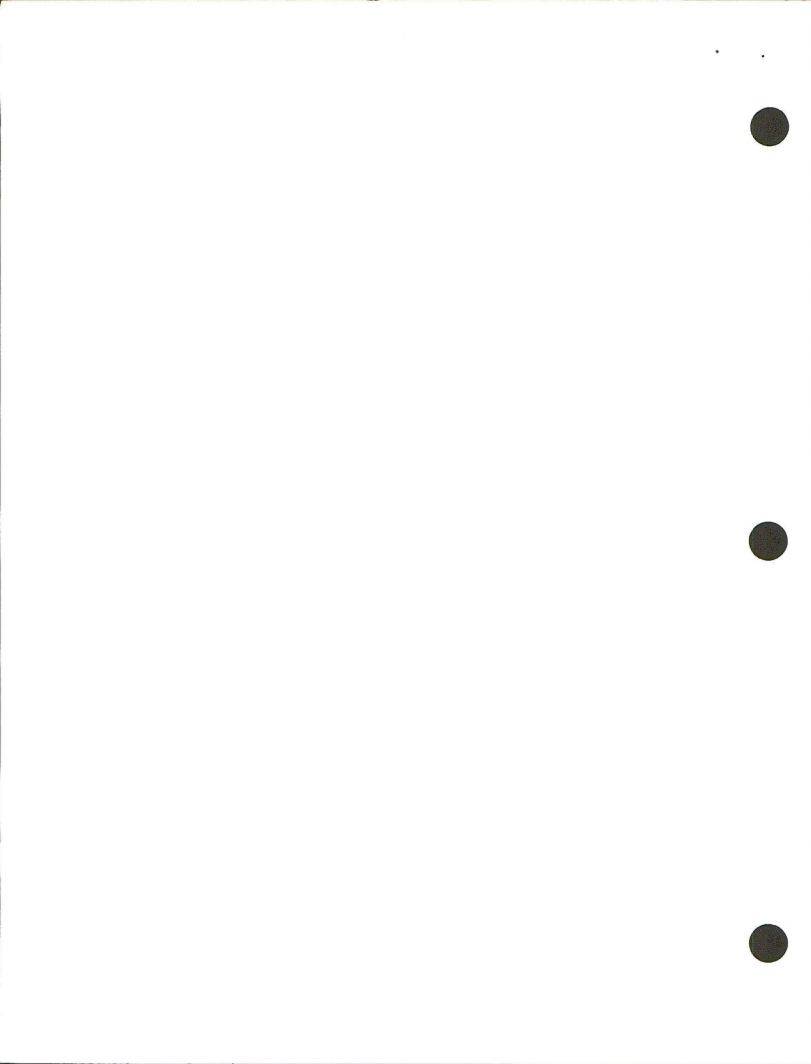
Sagebrush location

Grasses

Those grasses showing excellent adaptation included a majority of the seeded introduced wheatgrasses. They have continued to do well and have very consistent year to year emergence and vigor ratings. Of these, Oahe and Amur intermediate wheatgrass, Critana thickspike wheatgrass, Rosana western wheatgrass, Siberian wheatgrass, Nordan crested wheatgrass, Luna pubescent wheatgrass, Sodar streambank wheatgrass and Jose tall wheatgrass show great potential in future rehabilitation work.

The brome grasses also showed good adaptation on this site. Both mountain brome and Regar meadow brome have been consistent performers through the sampling years. Other species well adapted to this site include Sawki Russian Wildrye and green needlegrass.

Species that are somewhat adapted to revegetation work on this site include a good variety. Again, several wheatgrasses are present. Among



these are: C-30 western wheatgrass, bluebunch wheatgrass, slender wheatgrass, and Barton western wheatgrass. Shermans big bluestem and Kentucky bluegrass are two of the Poa species that occur here.

The wildrye were also quite prevalent in this group. Salina wildrye and C-43 basin wildrye fall into this category. Other grasses that are grouped with the above are: Durar hard fescue, orchardgrass, Timothy and Indian ricegrass.

Those grass species showing little promise in revegetation work are: sand dropseed, alkali sacaton, galleta, Arizona fescue and Griffiths wheatgrass.

Broadleaf Forbs

Of this listing, those species showing excellent adaptation are: arrowleaf balsamroot, Palmer penstemon, Lewis flax and gooseberryleaf globemallow.

Species somewhat adapted to this site included Rocky Mountain penstemon, Pacific aster and Bouncing bet.

Species showing no promise included small burnet, sweetanise, aster and vestina.

Leguminous Forbs

The seeded legumes which were well adapted included several vetch species. These are: Penngift crownvetch, Utah sweetvetch and Astragalus. A mixture was also seeded (1973 seeding) with a variety of broadleafed forbs and legumes.

The seeded alfalfas also did well. Both rambler and rhizoma Alfalfa have excellent emergence and vigor. Madrid yellow sweetclover also performed well on this site.

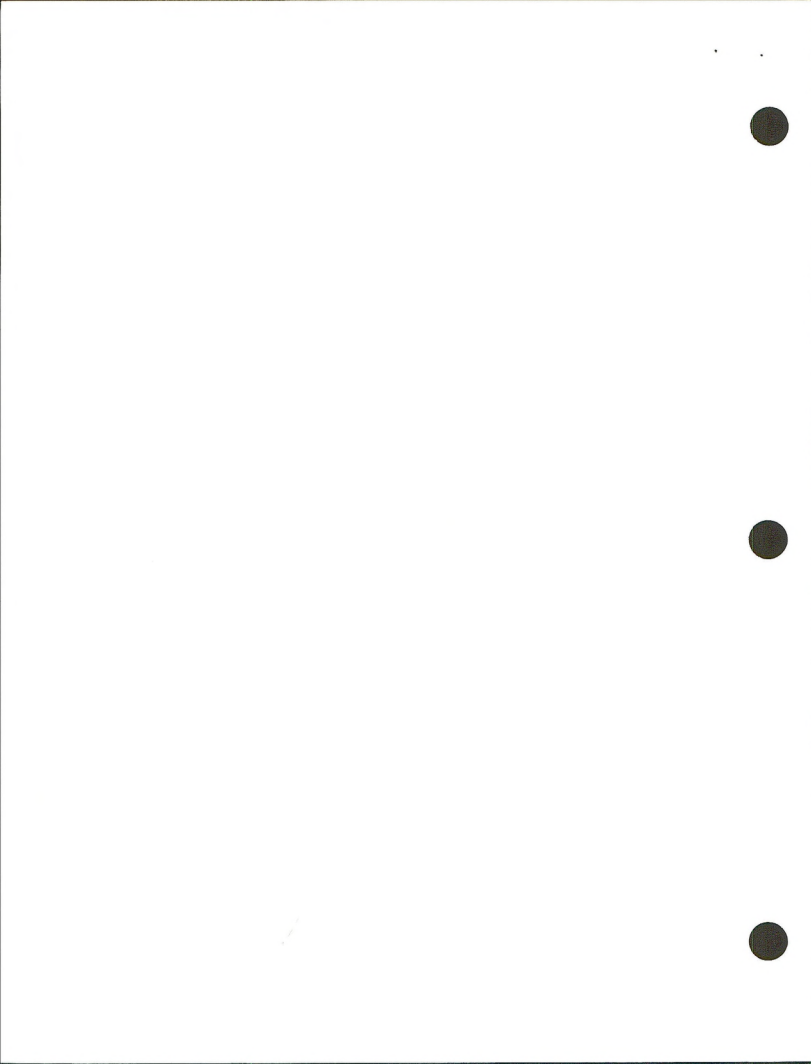
Species that were somewhat adapted included two vetch species. Both sicklepod and Lutana ciser milkvetch exhibited these characteristics.

Only two legumes seemed poorly adapted to this site. Mountain lupine and purple prairie clover had very poor establishment success.

Shrubs

A consistent species through the years has been green ephedra. It has continued excellent adaptability from year to year and shows great promise for future needs. Other well adapted shrub species included yellowbrush, winterfat, Stansbury cliffrose and Antelope bitterbrush.

The list of unadapted species is long. True, curl-leaf and birchleaf mountain mahogany all did poorly. Snowberry, winterberry, Silver buffalo-berry and serviceberry also showed little promise. Desert peachbrush, black sagebrush and rubber rabbitbrush also did poorly. Other poorly adapted species included: Desert Molly, common bladdersenna, black chokecherry, ceanonuus deer and squaw, blueberry elder, skunkbush sumac, New Mexico forestiera and Russian olive.



Selected species for seeding prescription

If regulations demand replacement of only native species a good combination of grasses, forbs and shrubs is available. Species that would do well on this location include: Critana thickspike wheatgrass, Sodar streambank wheatgrass, Rosana western wheatgrass, mountain brome and green needlegrass. Acceptable native broadleaf forbs would include Lewis flax, Palmer penstemon, and arrowleaf balsamroot. Good legumes available are Utah sweetvetch and penngift crownvetch. Native browse species would include green ephedra, yellowbrush, winterfat, Stansbury cliffrose and antelope bitterbrush.

If both introduced and native species can be used, all the species mentioned in the well adapted category would give excellent results.

Low pinyon-juniper

Grasses

A large number of grass species are well adapted to this location. The introduced and native wheatgrasses are again impressive in year to year emergence and vigor. Those exhibiting excellent characteristics are Amur and Oahe intermediate wheatgrass, Nordan crested wheatgrass, Critana thickspike wheatgrass, Sodar streambank wheatgrass, Siberian wheatgrass, Rosana western wheatgrass, Luna pubescent wheatgrass, slender wheatgrass, and bluebunch wheatgrass. Their use in a revegetation plan can greatly increase the success of the rehabilitation process.

The brome grasses also did quite well on this site. Both Regar meadow brome and Manchar brome showed encouraging results. Other grasses that showed excellent adaptability were Sawki Russian wildrye, Indian ricegrass, green needlegrass and Timothy.

Those species that were somewhat adapted include several genus of grass. Several wheatgrasses are included in this group. Among these are: Jose tall wheatgrass, Barton western wheatgrass, and C-30 western wheatgrass. Both C-43 basin wildrye and Salina wildrye fall into this category. Other species include Shermans big bluegrass, Kentucky bluegrass and orchardgrass.

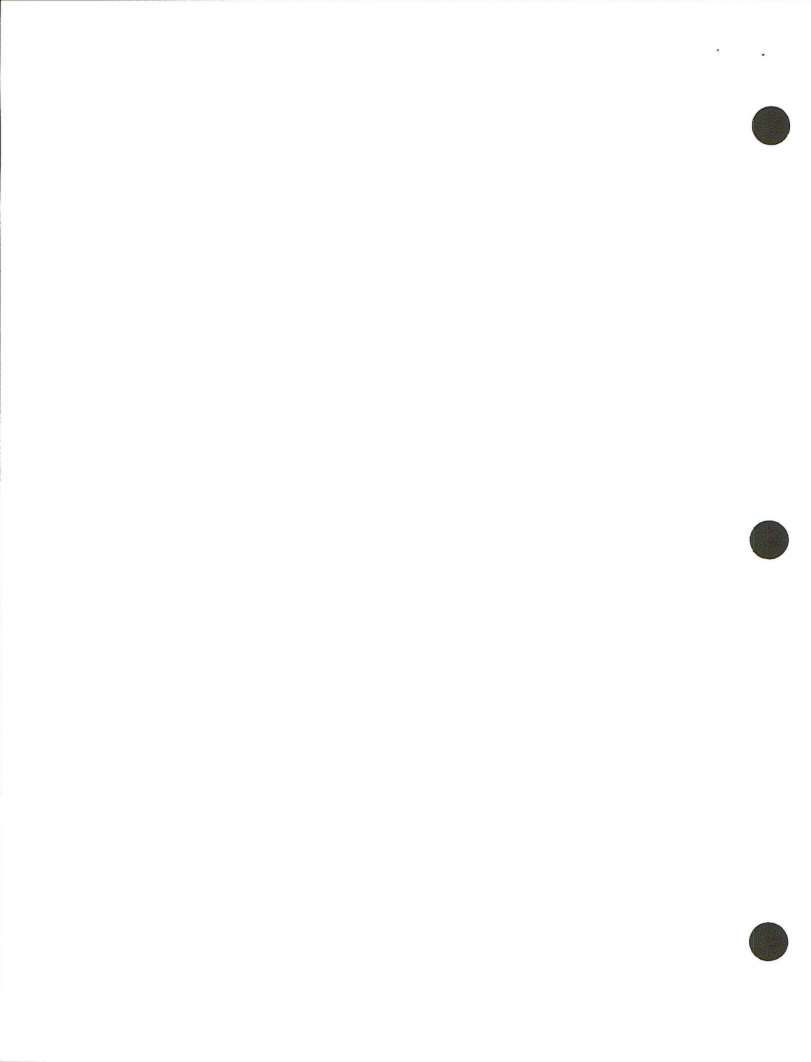
Those seeded species showing poor growth habits and adaptability included the following: Griffiths wheatgrass, Arizona fescue, alkali sacaton, sand dropseed, and galleta.

Broadleafed Forbs

Species showing excellent adaptability were Lewis flax, small burnet, gooseberryleaf globemallow and arrowleaf balsamroot. These species were constant by the years, and have remained productive throughout the yearly samplings.

Species showing varying adaptability on the low pinyon-juniper site included: Pacific aster, sweetanise, Palmer penstemon and bouncing-bet.

The only seeded broadleafed forb showing little promise in revegetation was Aster species. Little or no emergence was noted for this species on the site.



Leguminous Forbs

There is quite an array of well adapted legumes on this site. The vetch species again made an excellent showing. Sicklepod milkvetch, Penngift crownvetch, and the astragalus species showed excellent progress. The alfalfas also did well; both rambler and rhizoma alfalfa exhibited excellent characteristics. Madrid yellow sweetclover also did well on this site.

Only two vetch species seemed variable in adaptability on the low pinyon-juniper site. Both Lutana ciser milkvetch and Utah sweetvetch showed only somewhat adaptable characteristics.

Of the legumes, only purple prairie clover seemed wholly unacceptable as a potential revegetation species. As on all sites, purple prairie clover did very poorly.

Shrubs

The list of shrubs showing excellent adaption to this site is rather limited. Green ephedra, again showed superior adaption to the site conditions. Yellowbrush and winterfat were the only other species showing a good degree of promise.

The list of species somewhat adapted to the site is a bit longer. Serviceberry and snowberry showed signs of their value in a revegetation plan. Other species included: true mountain mahogany, rubber rabbitbrush and Stansbury cliffrose.

As would be expected, the list of unadapted shrub species is lengthy. Both big sage and black sage exhibited poor adaptability. The saltbush species also faired poorly on this site. Four-wing saltbush, Shadscale saltbush, Gardners saltbush and Nuttalls saltbush show little promise here. Other shrubs showing little promise are as follows: desert Molly, skunkbush sumac, birchleaf mountain mahogany, silver buffaloberry, ceanothus-deerbrush, and ceanothus squawcarpet.

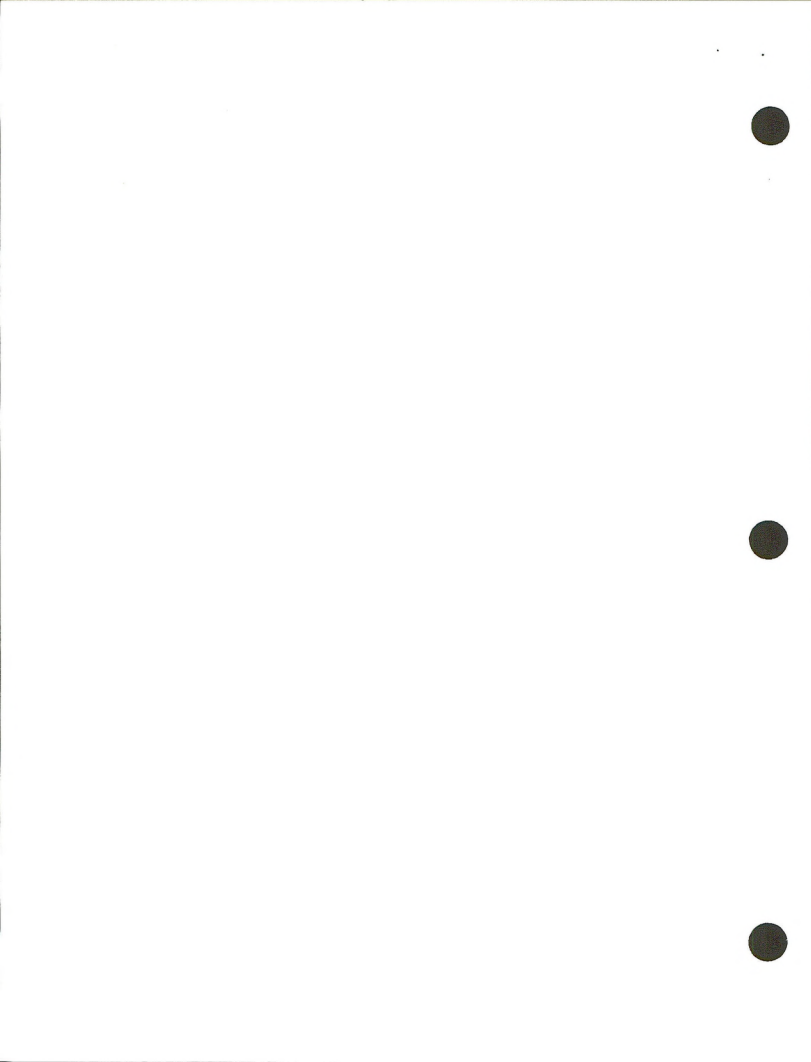
Selected species for seeding prescription

If regulations dictate replacement of native species a good list is available to choose from. The wheatgrasses again comprise the majority of acceptable species. Good species to use include: Rosana western wheatgrass, Critana thickspike wheatgrass, Sodar streambank wheatgrass, slender wheatgrass and bluebunch wheatgrass. Other natives that could be used would include Indian ricegrass (if a good seed source is available) and green needlegrass.

Acceptable broadleaved native forbs to include would be: Lewis flax, gooseberryleaf globemallow and arrowleaf balsamroot. Legumes which have good potential include: Penngift crownvetch, and possibly Utah sweetvetch.

Only three shrub species could be included in a native mix. Green ephedra, yellowbrush and winterfat would be used.

If a mixture of natives and introduced species could be applied, all the species in the well adapted categories would be acceptable in rehab-



ilitation.

High pinyon-juniper

Grasses

The list of well adapted grasses is very complete for this location. As in the previous sites, the wheatgrasses constitute a majority of potentially useful revegetation species. Nordan crested wheatgrass, Amur and Oahe intermediate wheatgrass, Jose tall wheatgrass, Rosana western wheatgrass, Sodar streambank wheatgrass, Siberian wheatgrass, Luna pubescent wheatgrass, and Critana thickspike wheatgrass are all consistent performers.

The brome grasses also did well on the high pinyon-juniper site. Their performance here, as in the previous sites, is encouraging. Regar meadow brome, mountain brome and Manchur brome showed excellent growth habits and persistence on the site. Other species showing excellent characteristics were: green needlegrass and Durar hard fescue.

Species showing partial adaptability on this site also include a good variety. Several wheatgrasses are present here as well. Barton western wheatgrass, slender wheatgrass, C-30 western wheatgrass and bluebunch wheatgrass constitute this genus representation.

Other partially adapted species include: Sherman big bluegrass, Kentucky bluegrass, C-43 basin wildrye, Sawki Russian wildrye, Salina wildrye, Indian ricegrass, orchardgrass, and Arizona fescue.

Those species poorly adapted on this site include the following species: Griffiths wheatgrass, alkali sacaton, sand dropseed, galleta, and Timothy.

Broadleafed Forbs

Broadleafed forbs did very well on this site. The well adapted species included: arrowleaf balsamroot, bouncing-bet, small burnet, Lewis flax, Palmer penstemon, Rocky mountain penstemon, gooseberryleaf globemallow, and Verbena.

Those somewhat adapted included the following: Pacific aster, sweetanise and the seeded mixture of species.

Of the broadleafed forbs, none seemed wholly unacceptable for rehabilitation on this site.

Leguminous Forbs

Again, on this site, the vetch and alfalfa species gave excellent results. Both Penngift crownvetch and Utah sweetvetch did well, and rambler and rhizoma alfalfa showed similar excellent results.

The partially adapted species included: sicklepod milkvetch, Lutana ciser milkvetch and the seeded Astragalus species.

The legumes had several species poorly adjusted to this site which show very little promise. Mountain and silky lupine and purple prairie clover

exhibited these characteristics.

Shrubs

There is quite a good selection of shrubs available on the high pinyon-juniper location. Green ephedra, again, does well here, as does yellowbrush. Other species showing promise include: antelope bitterbrush, Stansbury cliffrose, desert bitterbrush, black chokecherry and common bladdersenna. This site seems well adapted to shrubs and consideration should be given to their use in future programs.

Species that showed variable adaptability included: winterfat, Russian olive (a tree species), big sagebrush, rubber rabbitbrush and true mountain mahogany.

A lengthy list of unadapted shrubs on this site has been compiled. The saltbush species did poorly on this site. Four-wing, shadscale, Gardners and Nuttals saltbush all fared poorly.

Other poorly adapted species included: winterberry, serviceberry, snowberry, silver buffaloberry, ceanothus deerbrush and squawcarpet, desert peachbush, desert Molly, black sagebrush, birchleaf mountain mahogany, blueberry elder and skunkbush sumac.

Selected species for seeding prescription

For strictly a native reseeding venture, there is a very good selection of species to choose from.

Selected grasses would include: Critana thickspike wheatgrass, Rosana western wheatgrass, Sodar streambank wheatgrass, mountain brome, and green needlegrass.

Well adapted native forbs would include: of the broadleafed ones, arrowleaf balsamroot, Lewis flax, Palmer penstemon, Rocky mountain penstemon, verbena, and gooseberryleaf globemallow. Leguminous forbs would include Penngift crownvetch and Utah sweetvetch.

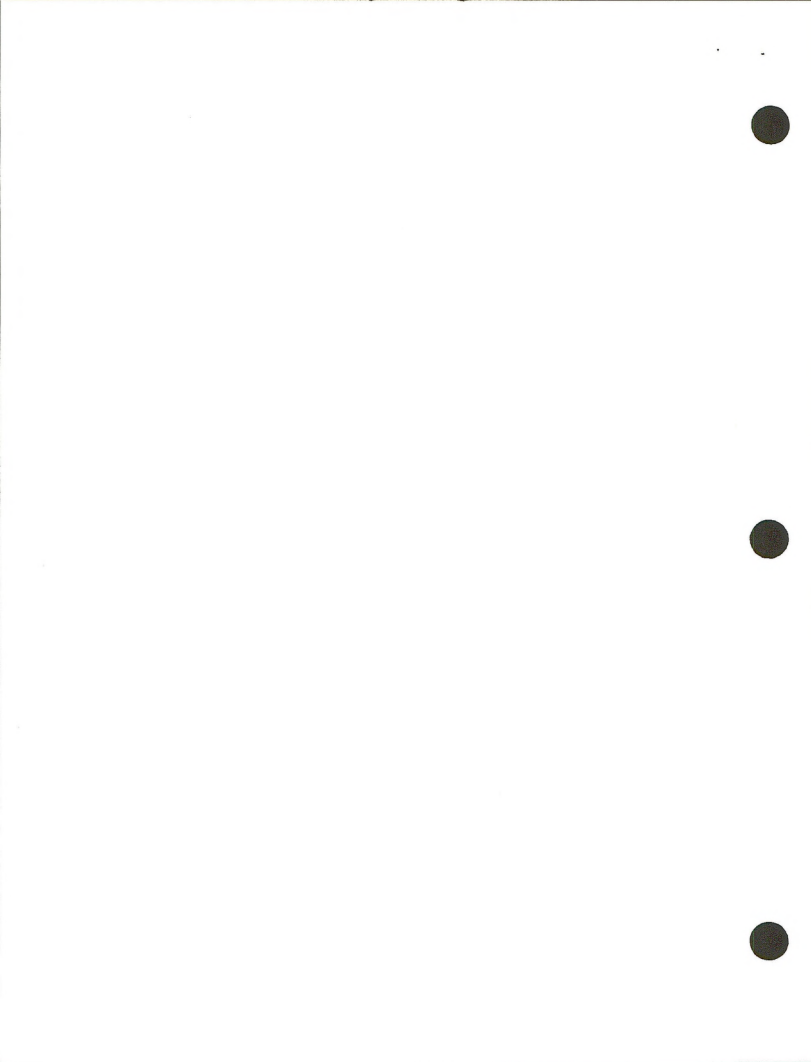
Adapted native shrubs would be: yellowbrush, ephedra, Stansbury cliffrose, black chokecherry, common bladdersenna, desert and antelope bitterbrush.

If combinations of native and introduced species are used, all the species falling into the well adapted category would give excellent results.

Mountain browse

Grasses

The mountain browse location showed the largest number of well adapted species. The wheatgrasses were joined by a greater variety of grass genera and a good mixed community occurred. The wheatgrasses showing excellent characteristics included: Nordan crested wheatgrass, Critana thickspike wheatgrass, Jose tall wheatgrass, Amur and Oahe intermediate wheatgrass,



Rosana western wheatgrass, Sodar streambank wheatgrass, Barton western wheatgrass, slender wheatgrass, bluebunch wheatgrass, and Luna pubescent wheatgrass.

The brome-grasses and wildryes also did very well on the mountain browse site. Mountain brome, Regar meadow brome, and Manchar brome showed excellent sampling results. Both C-43 basin wildrye and Sawki Russian wildrye exhibited excellent characteristics.

Other well adapted grass species included are: Durar hard fescue, Arizona fescue, green needlegrass, and Timothy.

The list of partially adapted species is somewhat smaller than other locations. In fact, the emergence of figor of these species is probably equal of several better adapted species on the previous sites, but in comparative ratings to other species on this site seemed less than good in adaptability. The species included in this category were: Indian ricegrass, Kentucky bluegrass, Shermans big bluegrass, orchardgrass, and Salina wildrye.

The list of unadapted species includes only four species. Griffiths wheatgrass, alkali sacaton, sand dropseed, and galleta all showed poor responses.

Broadleafed Forbs

The widest selection of forbs exists in the mountain browse location. Species found to have excellent adaptability include: Rocky mountain penstemon, bouncing bet, arrowleaf balsamroot, Lewis flax, and sweetanise. The forb mixture rows also did very well on this site.

Gooseberry-leaf globemallow, Pacific aster, Palmer penstemon, and small burnet showed somewhat adaptable growth characteristics on the mountain browse location.

Species poorly adapted to this location included desert Molly and Verbena. Both these species should be left out of this type in future experiments.

Leguminous Forbs

The legumes did very well on this site. Excellent leguminous forbs include a good variety of vetch, alfalfa and lupine species. Among these are: Lutana ciser milkvetch, Penngift crownvetch, Utah sweetvetch, Rambler alfalfa, rhizoma alfalfa, mountain lupine, and silky lupine. Astragalus species also did well on this site.

Sicklepod milkvetch was the only legume in the partially adaptable category. However, two legumes fell in the poorly adapted category. Both Madrid yellow sweetclover (dies out) and purple prairie clover did poorly here.

Shrubs

Excellent shrub species included a good variety of species. Green



ephedra did well as expected. Other good shrub species were: black chokecherry, yellowbrush, antelope bitterbrush, and Stansbury cliffrose. This site has the potential to support a diverse population of shrub species and this diversity should be included in the rehabilitation plan.

Partially adapted species include: black sagebrush, big sagebrush, rubber rabbitbrush, bitterbrush (desert), common bladdersenna, winterfat, curl-leaf mountain mahogany, desert peachbrush, snowberry and serviceberry. These species should be used to fill gaps in a diverse reseeded community.

Poorly adapted species included all the saltbrushes; four-wing saltbush, Shadscale saltbush, Gardners saltbush, and Nuttals saltbush. In addition, the following species were unacceptable: true mountain mahogany, Russian olive, skunkbush sumac, blueberry elder, silver buffaloberry, and winterberry.

Selected species for seeding prescription

Again, if regulations warrant only native species, the following can be used: Critana thickspike wheatgrass, Sodar streambank wheatgrass, western wheatgrass, Barton western wheatgrass, Rosana western wheatgrass, C-43 basin wildrye, mountain brome, green needlegrass, slender wheatgrass, bluebunch wheatgrass and Arizona fescue.

Good native broadleaved forbs include: Rocky mountain penstemon, arrow-leaf balsamroot, Lewis flax, and sweetanise. Legumes to include would be: Pennngift crownvetch, Utah sweetvetch and mountain lupine.

Native shrub species that could be used are: black chokecherry, yellowbrush, antelope bitterbrush, green ephedra, and Stanbury cliffrose which all show good rehabilitation promise.

Both natives and introduced species can be picked from the well adapted category of grasses, broadleaved forbs, leguminous forbs, and shrubs. A good community of diverse vegetation can be established from this list.

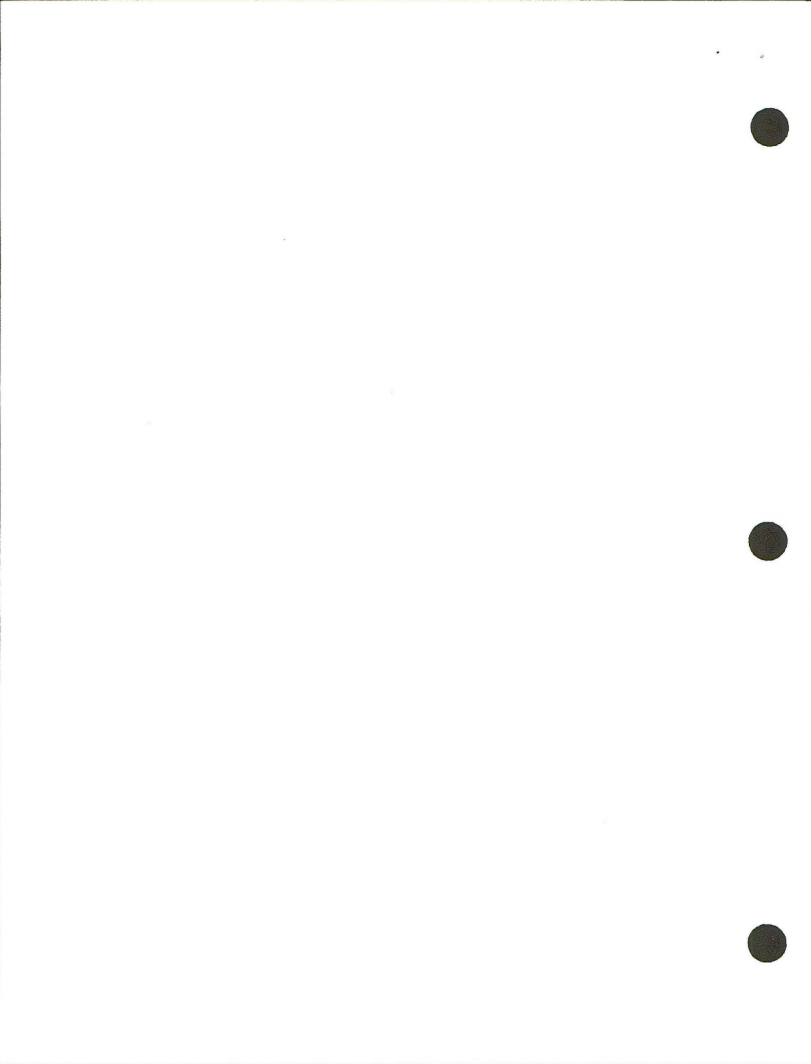
Possible reasons for seedling failures

The cause and effect of many factors is responsible for seedling failure on the four sites. No single factor is wholly responsible for the poor results shown by certain seeded species.

Undoubtedly, invasion by native annual and perennial plants caused competition for moisture and nutrients with the seeded species. With this invasion, the plants vigor, emergence and overall growth was retarded or eliminated.

The problem of species adaptability was linked somewhat to the site on which they were planted. Varying factors such as altitude, climate, soil types and differences, low precipitation, and a highly variable precipitation pattern accounted for problems in seedling establishment.

Other factors contributed to poor seedling emergence including: loss to herbivores by grazing and burrowing; loss of seed to birds and rodents; seeding warm season grasses (galleta, sand dropseed, alkali sacaton, etc.) in the fall instead of springtime; attack of fungi and disease



organisms on the young seeds; winter kill of the fall seedlings; excessive moisture availability causing the seeds to rot; soil crusting (surface); and improper seeding depth of species (1/4-1/2" grasses and 1/16-1/4" for forbs and browse).

Short description of best adapted species

Grasses

Amur and Oahe intermediate wheatgrass - was an excellent species on all four sites.* These are good species to seed because they are sod-formers, and if livestock grazing is important they are highly palatable. They are introduced species and only in native reseeding ventures would they be left out.

Nordan crested wheatgrass - an introduced bunchgrass which is highly palatable. This species had excellent emergence and vigor on all four sites. It appears to be one of the most promising seeded species.

Critana thickspike wheatgrass - this is one of the most promising native species planted. It has two characteristics which are sought in a revegetation species; it is an excellent sod-forming species and is a good livestock forage grass (though not as palatable as Amur, Oahe, Nordan and others). This species performed well on all four locations as well.

Rosana western wheatgrass - showed excellent growth habits on all four sites. Another of the promising native species. Like Critana, Rosana is a sod-forming species but is more palatable. Rosana has one characteristic which is of great importance in mine spoil reclamation. Rosana, Jose tall wheatgrass and Barton western wheatgrass are all salt-tolerant, which is an especially desirable trait.

Sodar streambank wheatgrass - another native species that performed excellently on all four sites. Sodar is also a sod-former, but is unpalatable as a forage species. This unpalatability is also advantageous in establishing a vegetative cover on the land. Since Sodar is unmolested by herbivores, it can be used as a strictly cover species very effectively.

Siberian wheatgrass - an excellent species on all four sites. Siberian is an introduced bunchgrass with varying palatability. This species seems to do well on harsh or favorable sites.

Luna pubescent wheatgrass - this introduced species does well on harsh and favorable sites, and shows promise (along with crested wheatgrasses) on the more difficult problem areas in a rehabilitation area. It is an excellent performer on all four sites. The species is also a sod-forming grass.

Jose tall wheatgrass - an excellent species on sagebrush, high pinyon-juniper and mountain browse. Jose was only somewhat adaptable on the low pinyon-juniper site. Jose is an introduced bunchgrass and is salt-tolerant.

*(sagebrush, low pinyon-juniper, high pinyon-juniper, mountain browse)



Green needlegrass - a persistent, excellent species on all four sites. Another of the promising native species, green needlegrass is a bunchgrass with a good forage value. Seems to do well on harsh or favorable sites.

Regar meadow brome - seemed an excellent species on all four locations. The species does well on harsh or favorable sites as do the above species. Regar is an introduced bunchgrass.

Manchar brome - performed well on the mountain browse location, low pinyon-juniper, and high pinyon-juniper locations. Manchar is an introduced, sod-forming species. This species is also valuable for livestock due to its high palatability.

Mountain brome - this species showed excellent promise at the sagebrush, high pinyon-juniper and mountain browse locations. It is a native bunchgrass, but may be a rather short-lived perennial. Further sampling of the site will determine its ultimate adaptability.

Sawki Russian wildrye - species performed well on the low pinyon-juniper, sagebrush and mountain browse locations. It is an introduced bunchgrass with fair palatability on these locations.

Broadleaved Forbs

Arrowleaf balsamroot - performed excellently on all four sites. It is a native, which is highly palatable in late spring through mid summer, but tends to dry up (by late summer) and die out.

Lewis flax - Another native species which performed well on all four site locations. Seems to do well on harsh and favorable site conditions.

Gooseberryleaf globemallow - performed well at the low pinyon-juniper, high pinyon-juniper and sagebrush locations. This is another native forb with rhizomes.

Leguminous Forbs

Penngift crownvetch - showed excellent characteristics on all four site locations. This species is a very persistent native legume. It shows great promise in a legume-grass mixture.

Utah sweetvetch - another excellent native legume which performed well on the sagebrush, high pinyon-juniper and mountain browse locations.

Rambler alfalfa - an excellent species on all four locations. This is an introduced legume with rhizomes.

Rhizoma alfalfa - Also an excellent species on all four site locations. This species is also an introduced rhizomatous species.

Shrubs

Green ephedra - performed excellently on all four site locations. This native species has shown great persistence in the studies conducted. It is also an evergreen species and has good palatability for livestock or wildlife.



Yellowbrush - yellowbrush was also an excellent species on all four sites. This native species is not usually regarded as something one would want to reestablish on a disturbed site. However, due to its rapid growth and persistence its value should not be ignored. It is used somewhat by wildlife and livestock for forage and cover.

Antelope bitterbrush - performed well on the sagebrush, high pinyon-juniper, and mountain browse locations. A native species, it is highly palatable and is a staple of wildlife dietary needs. It is considered an "ice cream" plant.

Stansbury cliffrose - this species performed excellently on the sagebrush, high-pinyon juniper and mountain browse locations. It is also a native evergreen (as is antelope bitterbrush) with good palatability. The species does well on harsh sites.

Other promising species

Durar hard fescue - performed excellently on the mountain browse and high pinyon-juniper sites. This palatable, perennial bunchgrass is often used as a lawn grass, and is an introduced species.

Slender wheatgrass - performed well on the low pinyon-juniper and mountain browse locations. It is a native perennial with good forage values.

Bluebunch wheatgrass - also performed well at low pinyon-juniper and mountain browse locations. This native bunchgrass is also highly palatable for wildlife and livestock (an important native range grass).

Timothy - performed well on the low pinyon-juniper and mountain browse locations. An important introduced, perennial hay species in the United States. It commonly escapes from cultivation.

Indian ricegrass - performed well at the low pinyon-juniper site. A native perennial which is highly palatable.

C-43 basin wildrye - performed well on the mountain browse location. It is a native bunchgrass with good cover and forage values.

Arizona fescue - performed well at the mountain browse location. A native perennial which is an important forage species for livestock.

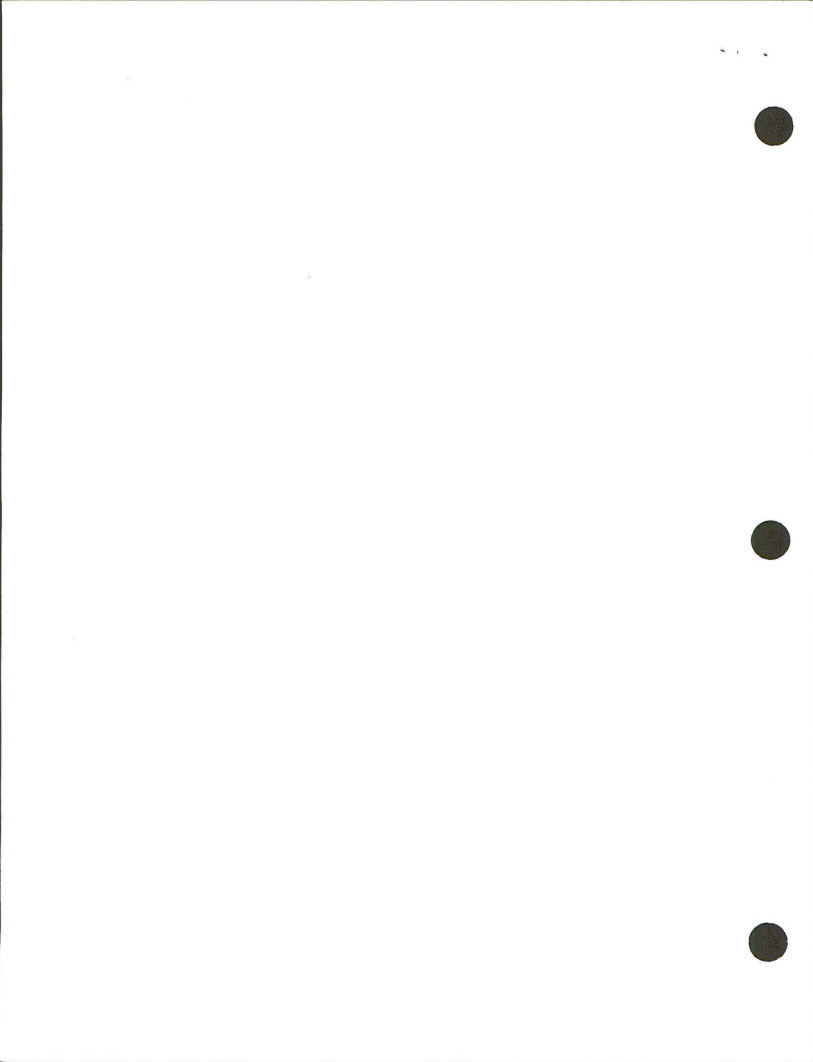
C-30 western wheatgrass - also did well on the mountain browse location. A native perennial which is highly palatable.

Broadleafed Forbs

Rocky mountain penstemon - did well on the high pinyon-juniper and mountain browse sites. This is a native species with a fairly good forage value.

Palmer penstemon - species performed well at the sagebrush and high pinyon-juniper locations. It is also a native species. The species does well the harsher sites.

Bouncing-bet - this species did well at the high pinyon-juniper and mountain browse locations. It is an introduced species which has rhizomes.



Small burnet - Species performed well at the low and high pinyon-juniper locations. It is an introduced, low growing species thought to be rather short-lived.

Sweetanise - performed excellently on the mountain browse location. This native species is a highly important mountain (high elevation) area range plant. It is also quite palatable.

Verbena - did well on the high pinyon-juniper location. This is also a native species.

Mixture - this combination of forb species did well on the mountain browse, and sagebrush sites.

Leguminous Forbs

Madrid yellow sweetclover - a good initial species throughout the sites, but seems to be dying out now. It performed well however, on the sagebrush and low pinyon-juniper sites. It is a rapid growing, introduced biennial.

Astragalus spp - this species performed well on the mountain browse, low pinyon-juniper and sagebrush sites. Native species.

Sicklepod milkvetch - performed well on the low pinyon-juniper location. Native species, perennial.

Lutana ciser milkvetch - performed well on the mountain browse location. A perennial species.

Mountain lupine - did well on the mountain browse site. A native species.

Silky lupine - also performed well on the mountain browse locations.

Shrubs

Winterfat - species performed well on the sagebrush and low pinyon-juniper locations. This native species is highly palatable for livestock and wildlife. It is also quite resistant to drought conditions.

Black chokecherry - did quite well on the high pinyon-juniper and the mountain browse locations. This species is a native one highly sought out by wildlife.

Common bladdersenna - did well on the high pinyon-juniper site. It is unpalatable, but is a native.

Desert bitterbrush - did well on the high pinyon-juniper location. This is also a highly palatable evergreen as is antelope bitterbrush, a much preferred big-game species.

